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CONTRIBUTION TO CIM SPECIAL VOLUME ON COAL IN CANADA
Chapter Title: Resources and Reserves

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PURPOSE OF REPORT AND BACKGROUND

This report represents a contribution by A.S. Romaniuk* and H.G. Rushton** to a special volume on coal in Canada, being produced by the Coal Division of the Canadian Institute of Mining and Metallurgy (CIM).

Twenty-four special volumes have been published by the CIM since "Structural Geology of Canadian Ore Deposits", Volume 1 was published in 1948. Three more special volumes are in preparation, including the coal volume referred to above - the first such volume entirely dedicated to coal mining and processing in Canada. In 1957 the Coal Division of CIM, along with the Metal Mining Division, published "Mining in Canada" for visitors attending the Sixth Commonwealth Mining and Metallurgical Congress, which was hosted by Canada.

The proposal for a special volume on coal was made by D.K. Faurschou, the Coal Division's representative on the Special Volumes Committee of CIM, at the annual business meeting in Toronto on April 20, 1980. At the Division's annual business meeting in Calgary on May 3, 1981 it was announced the project was under way and Professor Tom Patching of the University of Alberta had agreed to take on the task of Editor-in-Chief. Assembling the contributions of some forty individuals covering just as many facets of coal in Canada - with some inevitable overlaps - has undoubtedly been a heavy burden to Professor Patching. The product will serve as a reference work to those working in and around coal, as well as to students who are planning careers relating to this fascinating commodity.

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BUT DU RAPPORT ET RENSEIGNEMENTS PRÉLIMINAIRES

Ce rapport constitue la contribution apportée par A.S. Romaniuk* et H.G. Rushton** au volume spécial sur les charbons du Canada, publié par la division des charbons du Canadian Institute of Mining and Metallurgy (CIM).

Depuis la parution en 1948 du premier volume intituté Structural Geology of Canadian Ore Deposits, le CIM a publié vingt-quatre volumes spéciaux. Trois autres volumes spéciaux sont en préparation, incluant le volume sur les charbons du Canada mentionnné précédemment, le premier de la sorte dédié entièrement à l'exploitation et au traitement des charbons du Canada. En 1957, la division du charbon du CIM, en collaboration avec la division de l'exploitation minère des métaux, a publié Mining in Canada offert aux visiteurs qui ont assisté au Sixth Commonwealth Mining and Metallurgical Congress organisé par le Canada.

L'idée de publier un volume spécial sur le charbon a été formulée par D.K. Faurschou, représentant de la division du charbon au sein du Comité des volumes spéciaux du CIM, lors de la rencontre annuelle tenue alors le 20 avril 1980 à Toronto. À de la rencontre annuelle de division, qui a eu lieu le 3 mai 1981 à Calgary, on a annoncé que le projet avait été amorcé et que le professeur Tom Patching de l'Université d'Alberta avait accepté le poste d'éditeur en chef. La professeur Patching a alors hérité d'une tâche énorme: rassembler le travail de près de quarantes personnes qui ont étudié les charbons du Canada sous autant d'aspects, sans toutefois pouvoir éviter les recoupements. Ce volume servira comme ouvrage de référence, tant pour ceux dont le travail porte sur le charbon que pour les étudiants qui espèrent travailler dans ce domaine.

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UNITS OF MEASUREMENT

Units of measurement in this report are in the International System of Units (SI) as approved for official use by the Canadian Standards Association and Metric Commission Canada. These units have been adopted by the Mining Association of Canada and the Coal Association of Canada. To assist with the shift of metric units these two associations have published "Metric Practice Guide for the Canadian Mining and Metallurgical Industries", 1978 (1).

Appendix "A" lists some useful conversion factors along with SI prefixes.

CANADA'S COAL RESOURCES: AN OVERVIEW

The opening chapter of this special volume, by A. Ignatieff, places into perspective Canada's coal resource base as part of the world scene. This chapter will focus on the Canadian scene.

The last official assessment of Canada's coal resources and reserves was done by the Department of Energy, Mines and Resources and presented in Report ER 79-9 "Coal Resources and Reserves of Canada", published in December 1979 and authored by H.U. Bielenstein, L.P. Chrismas, B.A. Latour and T.E. Tibbetts (2). The Geological Survey of Canada has a continuing project concerned with coal resource assessment as does CANMET, whose concern is with coal reserve assessment and coal quality. As well, Alberta's Energy Resources Conservation Board (ERCB) has a continuing assessment program for coal in Alberta and publishes an annual reserves report, the current issue of which is cited as reference (3). There is a difference in resource and reserve terminology as used by EMR and ERCB and this has a major effect on derived tonnages for Alberta. This difference will be discussed later.

In 1982 the Department of Energy, Mines and Resources produced a map entitled "Canada - Coal" (4) which outlines coalfields and illustrates coal import and export movements for the years 1981 and 1980. A copy of this map is contained in the map pocket of this publication.

Two other resource assessment reports are noteworthy, the first is "Coal Resources of Southern Saskatchewan: A Model for Evaluation Methodology" by J.A. Irvine, S.H. Whitaker and P.L. Broughton (5) which is one of the major outputs of a joint federal-government study of southern Saskatchewan's lignite deposits. (Another output from this same study is the Geological Survey of Canada's SASCO file, a computer-processable file holding borehole and coal quality data.) The second is "Deep Coal Resources of the Interior Plains" by G.D. Williams and M.C. Murphy (6) which identifies coal resources from nearly 4,000 petroleum exploration boreholes.

The description of coal occurrences in Canada as given in Report ER 79-9 (2) is current (as of 1982) and with the map Canada-Coal is the basis for the following text.

Newfoundland: At various times between 1897 and 1948, small amounts of surface exploration, drilling and underground exploration were carried out on both the Howley and St. George's deposits. These investigations showed the presence of strongly faulted Pennsylvanian coal beds with steeply dipping, high ash coal seams, rarely more than three feet thick and commonly having shale partings. These adverse factors discouraged further exploration. Estimates of the coal resources have not been included in this report because of a lack of sufficient information.

Nova Scotia: The estimates of resources in Nova Scotia are based largely on data from a federal-provincial drilling program which spanned 1977-1979 together with data provided by the Cape Breton Development Corporation. The Sydney Coalfield is by far the most important in the province and is estimated to contain 1 603 megatons of measured plus indicated resources of mainly high volatile bituminous coal. Only a very small part of the field is on land with the bulk of it beneath the Atlantic Ocean. The coal, like that of all fields in Nova Scotia, is Pennsylvanian in age. Three seams, the Hub, Harbour and the Phalen, have been exploited more extensively than others because of their lower sulphur content and greater mineable thickness. The Pictou, Springhill and Joggins Coalfields have been mined extensively. The remaining resources in each field are relatively small with some being difficult of access because of the presence and dangerous condition of old mine workings.

There are four small coalfields along the west coast of Cape Breton Island. They are Port Hood, Mabou, Inverness and St. Rose-Chimney Corner. The quality of the coal, structural conditions and the extensive submarine position of these small fields have restricted their exploration and development.

New Brunswick: The only currently productive coalfield in New Brunswick is the Minto Coalfield which contains one seam averaging 0.4 m thick. The better part of the field has been mined out and the remaining measured, plus indicated resources are estimated to be 19 megatonnes.

Drilling about 80 km northeast of the Minto Coalfield has delineated two small coalfields, each containing one thin seam and totalling some 14 megatonnes of measured plus 14 megatonnes of indicated resources.

Ontario: A thin, Lower Cretaceous sequence called the Mattagami Formation underlies the southern part of the moose River Basin which lies adjacent to the Canadian Shield of northern Ontario. The sequence consists of sandstones, clays and lignitic coal and the area underlain by it is known as the Onakawana Coalfield. Some 218 megatonnes of measured resources of high moisture lignitic coal have been delineated over an area of about 39 km^2.

Manitoba: Thin, lignitic coal seams which are an extension of the deposits in southern Saskatchewan occur in southwestern Manitoba. The few outcrops scattered over the deposit reveal that the seams are too thin to be included within the limits set for resources in this report.

Saskatchewan: Seams of Paleocene lignitic coal of mineable thickness are confined mainly to four discrete major basins: Estevan, Willowbunch, Wood Mountain and Cypress. These basins were delineated and evaluated by drilling carried out under a joint federal-provincial coal evaluation program as well as from data provided from drilling by companies (5).

Lignitic coal also occurs in the Wapawekka area near Lac La Ronge in central Saskatchewan. The limited data available indicate that the coal is rather high in ash and that the seams rarely attain the minimum mineable thickness of 1.5 m.

Alberta: The province is estimated to have large resources of bituminous and subbituminous coal (Table 1). These estimates have been prepared by the Alberta Energy Resources Conservation Board according to parameters, evaluation methodologies and a classification scheme that all differ significantly from those of the Department of Energy, Mines and

Resources. The accommodations that have been made between the two systems are detailed in the footnotes to Table 1. In general the Board's estimates tend to be higher than those produced under the Department's system but the extent of the difference is difficult to determine.

The province is divided into three regions, each containing deposits of similar age and characteristics, namely the Mountain, Foothills and Plains regions.

The Mountain Region extends along the eastern flank of the Rocky Mountains, and contains mostly medium and low volatile bituminous coal deposits mainly of Upper Jurassic and Lower Cretaceous age. The coals are commonly friable and the seams are steeply inclined, highly sheared and faulted. In areas of intense folding the seams are often thickened in the hinge areas. Such areas of thick coal seams are of particular interest to mining companies as possible sites for surface mining operations.

The Foothills Region adjoins the eastern edge of the Mountain Region and contains mainly high volatile bituminous coals of Upper Cretaceous and Lower Tertiary ages. They appear to be developed best in the area between the North Saskatchewan and Athabasca rivers. Like their counterparts in the Mountain Region, these coal beds have been sheared, faulted and folded. At the outcrop or near the surface anomalous thickening can provide favourable sites for surface mining.

The Plains Region is characterized by generally flat-lying or gently inclined seams of Upper Cretaceous and Lower Tertiary age and mainly of subbituminous rank. Outcrops are uncommon and information about the deposits is largely obtained through drilling. The proximity to surface of some of the seams allows for their recovery by surface mining methods - the method of which almost all the coal in the region is produced.

British Columbia: Coal deposits are widely scattered through British Columbia. Estimates of the coal resources of this province are based on information obtained from the British Columbia Department of Mines and Petroleum Resources and other sources available to the Department of Energy, Mines & Resources. For purposes of discussion the tabulation of resources of the province has been divided into three regions namely, southeastern, northeastern and other.

The coal deposits of southeastern British Columbia are commonly referred to as those in the Crowsnest Region. This area, mined since 1897,

has been extensively explored and is the only area in the province where coal is now (1982) being mined although large scale developments are underway in northeastern British Columbia. The deposits are Upper Jurassic in age and are part of the southern end of the Mountain Region as described for Alberta with the notable difference that they contain considerably more seams that are generally of greater thickness than in adjoining areas of Alberta.

The coal deposits of northeastern British Columbia are Lower Cretaceous in age and are the northern extension of the coals that occur in the Mountain Region of Alberta. The region has undergone much exploration in the past several years resulting in the construction of two new mines (Quintette and Bullmoose), a new townsite (Tumbler Ridge), a new branch railway line and new port facilities at Prince Rupert.

Several small basins of Tertiary coal occur in the south-central part of the province, including Tulameen, Princeton, Merritt and Hat Creek Basins. The Hat Creek Basin is by far the most important because of the exceptionally thick (50, 70 and 150 m), near-surface, lignitic seams which give rise to very large tonnages in a small area. Jura-Cretaceous deposits occur in the Telkwa and Bowron River areas of central British Columbia. Mining experience at Telkwa over the past 30 years has shown the deposits to be faulted and to be intruded by igneous rocks. Recent exploration work at Telkwa suggests that more extensive deposits may be present. Small scale exploration in the Bowron deposit has indicated that the seams are of limited extent and irregular in thickness.

The Jura-Cretaceous deposits of the Groundhog Coalfield in northern British Columbia are little known and poorly understood although they are being further explored. Based on areal extent of the deposits and limited exploration, there appears to be some potential for development of low volatile bituminous and anthracitic coals.

Three areas underlain by Upper Cretaceous coal deposits occur on the east coast of Vancouver Island. The Nanaimo coalfield produced coal for many years, and the more accessible coal is considered to be mined out. The more accessible parts of the Comox Coalfield have largely been mined out, leaving the deeper less accessible coal, while in the Quinsam area to the north, recent exploration has indicated good potential for near-surface seams. What little is known about the remaining area of Suquash and other coal areas of Queen Charlotte Islands indicates structural and stratigraphic problems.

These low quality coals, locally intruded by igneous rocks (Queen Charlotte Islands), do not appear attractive for exploitation. Deeply-buried lignites are also known to exist in the northeast portion of Graham Island.

Northern Canada (north of 60° latitude): Significant occurrences of coal are wide-spread in the Canadian north although the information is almost entirely confined to reports of seams exposed in outcrop. Seams up to 9 m thick have been noted, but further details of these occurrences are not yet known. As yet not even speculative resources have been estimated for this large region, but such information as exists suggests the existence of large coal resources.

With few exceptions, past production has been limited to small scale operations for local consumption at such places as Pond Inlet, Aklavik and Paulatuk in the Northwest Territories and Carmacks, Whitehorse, Burwash Landing and Dawson City in the Yukon Territory.

RESOURCE AND RESERVE TERMINOLOGY

The definition of a mineral resource and what part of a mineral resource can be considered a "reserve" has been a subject for debate both in Canada and abroad for many years. Readers are referred to Appendices "C" and "D" for definitions.

The debate was brought into sharp focus in the early 1970's when oil and gas supply became a concern for governments at all levels. Canada's future coal supply likewise has been a subject for renewed federal government interest. In an address to the Canadian Conference on Coal in Regina on September 21, 1981 the Minister of State for Mines made two references to the adequacy of Canada's coal resource base, namely:

... "to allow exports on a virtually unrestricted basis implies that we are certain our resource base is sufficient to support both these exports and the foreseeable needs of our domestic markets."

... and

... "Canadians will want to be reassured that as our (coal) exports grow, the resource base is in fact adequate. For this reason, my department, in cooperation with the provinces, will re-activate its efforts to determine the quantity and quality of coal available with increasing emphasis on probable replacement costs, the effects of environmental restrictions on both production and utilization

related expecially to sulphur content, and other similar concerns." ...

The corporate sector, whose business is mining coal, has always had a reasonably stringent definition for coal reserves, as expressed in terms of geological assurance of existence, technical/economic feasibility of exploitation and rate/timing of production. This sector cannot deal with speculative quantities, unproven mining or beneficiation technology, or potentially unprofitable operations. On the other hand, organizations promoting coal sales are generally more liberal in their definitions of reserves, as they would not wish to discourage prospective buyers with limitations on recoverable coal tonnages or negative coal quality factors.

Neither resource nor reserve tonnages remain as firm numbers through time. Obviously, reserves are depleted by production and must be replaced. As factors affecting the economics of coal production (coal price, demand, technology) evolve, so do reserves at any point in time. As demand for coal rises, exploration effort increases as each coal owner seeks to establish recoverable coal reserves and gain a market share. The geological certainty of existence rises as the data base expands, as does knowledge on how best to mine and beneficiate the coal. Thus coal included in the resource base usually moves with time into the reserve category. However, fundamental difficulties in recovering a resource should not be ignored or glossed over. Touching on this issue is Ignatieff's observation (Chapter I) in which he states ... "it would be wise for generations of mining engineers in the future not to overlook the potential difficulties of deep mining in the high rank coals of Alberta and B.C. Cordillera Region".

The descriptor MEASURED is preferred within EMR to designate those coal resources whose geological existence is most assured. Ideally, this assurance would be quantified and expressed as a kriging variance or as a percentage error which in turn could be converted to a range for estimated tonnages. However, this geostatistical approach requires data bases and methodology which, with the exception of the SASKO file (5) and a few smaller data bases, are still under development. The alternative is to base terms such as MEASURED and INDICATED on certain maximum distances between reference points (usually boreholes) as was done in Report ER 79-9(2), for each of the major physiographic regions in Canada where coal is being mined. These distances are given in Appendix "B".

Once a coal deposit's tonnage is reasonably well assured the next dimension to be considered is the technical/economic feasibility of its exploitation. The usual way of assessing this facet is the production feasibility study which includes the identification of the specific mining method and production rate, a flow sheet for the coal preparation plant (assuming the coal will be beneficiated), saleable coal quality characteristics, the environmental impact assessment, manpower needs and needs for power, water, surface plant, transportation, housing, etc. Taxes and royalties must likewise be considered in this feasibility study. The subject of project feasibility would be imcomplete without mentioning one critical assumption about its future, namely that markets at current coal prices will exist for all the saleable product. This can be restated as an assumption that prices will generally remain above the total costs (both operating and capital) for the time period the coal deposit is being considered for production.

Production feasibility studies are required by provincial government regulatory agencies in Alberta and British Columbia before approval-in-principle is given, either to new coal projects, or to major expansions of existing operations. These feasibility reports, or reports produced by the regulatory agency in support of its decisions, become public documents, when approved, and are therefore an important source of data on coal reserve quantities, limiting criteria, representative coal qualities, mining methods, etc. Established mine operators usually undertake their own exploration programs and feasibility studies to derive coal reserves for the continuing operation of their mines but these data are not usually available to the public.

Without production feasibility studies it is easy to stray into that grey area, also referred to as the "argument zone", into which national reserve assessment reports have been known to disappear, only to reappear later, with "reserve" tonnages reduced by an order of magnitude.

Other important considerations are the rate and timing of production. Policy makers, coal producers, coal buyers and coal transporters are becoming increasingly concerned not only with the "how much" but also the "when" aspects of the coal supply question, especially in times of economic uncertainty. Feasibility studies on Canadian bituminous coals destined for the export or domestic market normally cover a time span of

15 years, which is the usual term for long-term supply contracts. Lower rank coal deposits destined for local power generation plants are evaluated for a 30 year time span, as this is the usual time considered reasonable to write off the capital cost of a power generating plant.

The foregoing considerations suggest that reserves are derived in a series of steps. The reserve terms used to describe the mental exercise of converting a coal deposit into a saleable product are defined in Appendix "C" and are as follows:

Level 1 represents COAL IN MINEABLE SEAMS

Level 2 represents RECOVERABLE COAL

Level 3 represents CLEAN COAL

Level 4 represents SALEABLE COAL

In the EMR classification reserves are part of MEASURED plus INDICATED RESOURCES which are of IMMEDIATE INTEREST and for which production feasibility studies have been completed, as illustrated in Fig. 1. Resources whose confidence level is at the low end of the descriptor scale, namely those considered INFERRED or SPECULATIVE, along with all resources of FUTURE INTEREST are not part of the reserves picture because such coal does not enter the foreseeable coal supply picture.

For discussion purposes an "argument zone" has been shown in Fig. 1, to reflect the two different approaches used to derive "reserves". In what might be identified as the geological approach, general factors such as maximum depth, minimum seam thickness and/or limiting stripping ratio are applied to coal resources located on a regional basis. The product is relatively high tonnages, compared to those tonnages resulting from an engineering/production feasibility study in which site-specific limiting criteria are applied to a coal deposit. Mine model studies can narrow the differences that crop up in the argument zone, but it remains to be seen if such computerized studies will replace any more than portions of the engineering/production feasibility study. The price obtainable for the product obviously plays a major role in any of these studies. Indeed, "reserves" may be more influenced by prices (either up or down) than any other single factor.

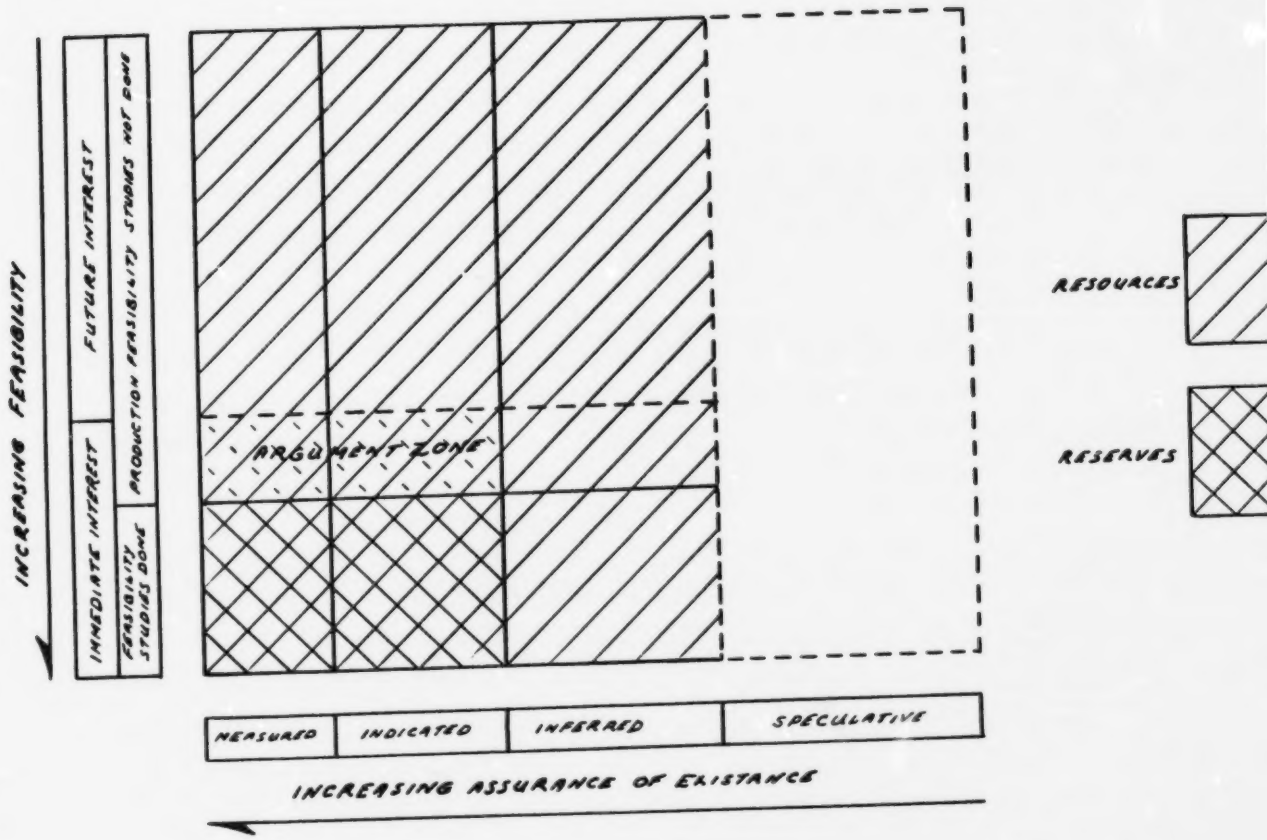

Fig. 1 - Coal resource/reserve classification scheme

As mentioned earlier the Province of Alberta has its own coal resource/reserve classification scheme. Its term definitions and a schematic representation are available in annual reports by the Energy Resources Conservation Board (ERCB) entitled "Resources of Coal: Province of Alberta" (3). The ERCB's parameters, evaluation methodology and reporting terminology differ from the EMR system and a direct correlation between the two systems is not possible. Generally, Alberta's coal reserve terms are less stringent than those used by EMR.

Before leaving the subject of coal reserve terminology it is worth noting that "coal" actually includes a wide range of commodities of different compositions, uses and values, unlike virtually any other mineral commodity. Coal spans the continuum from peat to anthracite. One tonne of saleable bituminous coal can be worth roughly five times that of one tonne of saleable

subbituminous coal. In time, coal reserve assessments should provide answers to questions of supply for different markets, e.g.

- metallurgical coal market
- export thermal coal market
- mine-mouth power generating market
- chemical feedstock market, including coal conversion to gaseous and liquid hydrocarbons.

It must also be recognized that certain coals may find a place in more than one market, with other coals confined to certain more narrow end-uses.

CHARACTERISTICS OF COAL BY PROVINCE AND COAL REGION

All ranks of coal occur in Canada, although no anthracitic coals have been produced since the closure of the Canmore Mines in 1979. Besides this wide range in rank, it is worth noting that coals of the same rank, but from different regions, can vary significantly when quality characteristics are compared. For example, much of the high volatile bituminous coal from the Sydney Coalfield in Nova Scotia is an agglomerating coal, high in sulphur and low in ash. The same rank of coal from the Coalspur Coalfield in Alberta is non-agglomerating, low in sulphur and high in ash. Appendix "D" summarizes the salient quality characteristics of coal in the major coalfields or coal regions of Canada.

COAL RESOURCE QUANTITIES

Table 1, updated from Report 79-9, gives a current (1982) estimate of Canada's coal resource quantities. The footnotes identify data sources and explain certain qualifications which apply to quantities cited.

A significant increase in the coal resources of the Sydney Coalfield in Nova Scotia, classed for the most part as high volatile A bituminous, occurred following an offshore drilling program in 1977-79, supplemented by marine seismic surveying (10). This in turn has given birth to the Donkin-Morien Project, a major new mining development by the Cape Breton Development Corporation.

Table 1 - Estimates of coal resources in Canada (1982) (megatonnes)

Area	Coal Rank[1]	Resources of immediate interest			Resources of future interest		
		Measured[2]	Indicated[2]	Inferred	Measured	Indicated	Inferred
Nova Scotia[3]							
Sydney	hvb	→ 1 603 ←		719	-	-	-
Other	hvb	48	41	38	3	50	128
Subtotal		→ 1 692 ←		757	3	50	128
New Brunswick[4]							
Minto	hvb	6	13	-	-	-	-
Other	hvb	14	14	1	-	-	-
Subtotal		20	27	1	-	-	-
Ontario[5]	lig		-	-	218	-	-
Saskatchewan[6]							
Estevan	lig	283	497	437	41	519	6 998
Willow Bunch	lig	747	1 044	1 420	68	1 704	10 388
Wood Mountain	lig	278	733	1 114	44	1 447	5 665
Cypress	lig	162	407	465	8	243	461
Subtotal		1 470	2 681	3 436	161	3 913	23 512
Alberta[7]							
Plains	sub (+ some hvb & lig)	37 000[8]	-[9]	890 000[10]	-	-	860 000[13]
Foothills	hvb	1 600	-	4 000[11]	-	-	5 500[14]
Mountains	lvb-mvb (+ some hvb)	8 000	-	6 000[12]	-	-	14 000[15]
British Columbia[16]							
Southeastern	lvb-mvb	6 286	9 436	36 317	-	-	-
Northeastern	lvb-mvb	996	462	7 719	-	-	-
Other	Mainly lig some sub-hvb	1 845	91	7 439	-	-	-
Canada totals	lig	3 315	2 772	10 875	379	3 913	23 512
	sub	37 000	-	890 000	-	-	860 000
	hvb	→ 3 339 ←		4 758	3	50	5 628
	lvb-mvb	15 282	9 898	50 036	-	-	14 000

(1) lig = lignitic; sub = subbituminous; hvb = high volatile bituminous; mvb = medium volatile bituminous; lvb = low volatile bituminous.

(2) Includes the reserves presented in Table 2.

(3) Based on federal/provincial drilling program and data from Cape Breton Development Corp.

(4) Based on information provided by New Brunswick Department of Natural Resources and N.B. Coal Ltd.

(5) Based on EMR study.

(6) Based on federal/provincial coal resource evaluation program in 1978[5], less production up to 1982.

(7) Estimates for Alberta are based on Energy Resources Conservation Board Report 82-31, December 1981 (ref. 3). Work by Williams and Murphy, 1981 (ref. 6) indicates that ERCB estimates up to December 1980 and earlier have been excessively conservative in identifying total coal resources for the Plains Region. Accordingly, ERCB has accepted the tenfold increase in the resource tonnage for plains coal as more realistic than earlier estimates. It should be noted that ERCB's parameters, evaluation methodology and reporting terminology differ from those used by EMR. For this table, the following accommodations have been made:

(8) ERCB "established resources"are reported as EMR "measured resources"; it is recognized these figures include some tonnages that EMR would report as "indicated".

(9) There is no ERCB category comparable to EMR "indicated".

(10) Refers to resources identified by Williams and Murphy, 1981 for all five Reliability Index categories, for seams ≥ 2 metres thick and < 300 metres deep.

(11) Represents one-half of ERCB "total resources" (i.e. 11.3 gigatonnes) less all of ERCB "established resources" (i.e. 1.6 gigatonnes)

(12) Represents one-half of ERCB "total resources" (i.e. 28 gigatonnes) less all of ERCB "established resources" (i.e. 7.983 gigatonnes)

(13) Refers to resources identified by Williams and Murphy, 1981 for all five Reliability Index categories, for seams ≥ 2 metres thick and 301 to 500 metres deep.

(14) Represents one-half of ERCB "total resources" (i.e. 11.3 gigatonnes)

(15) Represents one-half of ERCB "total resources" (i.e. 28 gigatonnes)

(16) Based on evaluations by EMR, British Columbia Ministry of Energy, Mines and Petroleum Resources and British Columbia Hydro.

(-) Not determined.

Of significance to Alberta's subbituminous (and perhaps high volatile bituminous) coal resources base is the report by Williams and Murphy (6) in which suites of geophysical logs from 2 448 boreholes drilled in the Plains Region in search of oil and gas were examined for coal intersections. The tenfold increase in the "total resource" coal base for the Plains Region is considered by Alberta's Energy Resources Conservation Board (ERCB) to be more realistic than the Board's earlier estimates. However, until such time as production feasibility studies are done on individual deposits within this massive inferred resource base, none of this coal can be considered a reserve. Resource tonnages for Alberta, as shown in Table 1, have been provided by ERCB (11). As noted earlier, ERCB's parameters, evaluation methodology and reporting terminology differ from those used by EMR. Readers are referred to the accommodations noted in the footnotes to Table 1.

Although eight provinces contain coal deposits, only five produce coal. In terms of measured plus indicated resources of immediate interest (the resource base out of which coal reserves are derived) the three western provinces have the largest deposits. Considering the resource base just mentioned, 100% of the lignitic, 100% of the subbituminous, 48% of the high volatile bituminous and nearly 100% of the low and medium volatile bituminous coals are located in British Columbia, Alberta and Saskatchewan.

Excluded from the resource estimates are Newfoundland, Manitoba and all of Canada north of 60^{o}N latitude. Little information is available concerning coal deposits in these areas. However, the indications are that resources in northern Canada are large and may well become a significant part of future resource estimates.

COAL RESERVE QUANTITIES

Coal reserve quantities listed in Table 2 fit the definition of coal reserves stated in Appendix "C". These tonnages are part of the MEASURED and INDICATED RESOURCES OF IMMEDIATE INTEREST as defined in Appendix "B", except for the resource numbers given for Alberta.

The reserve quantities given in Table 2 for Alberta are those defined by ERCB as "mine permit reserves". Developers wishing to mine coal

in Alberta must first obtain a permit and license from ERCB. An application for a permit must contain extensive site-specific information on in-situ coal quantities, coal quality, proposed mining methods, marketing of coal etc. This may be considered the equivalent of an engineering feasibility study. Thus, ERCB's MINE PERMIT RESERVES fit EMR's reserve definitions.

Tonnage figures for British Columbia and for Canada as a whole have purposely not been totalled, because such summations would include coal of various ranks which, when lumped together, give a number with little meaning. Totals can more usefully be expressed in terms of heating value, as shown in Table 3. Coal deposits with less than 2 megatonnes recoverable coal have been excluded from this table.

Table 2 - Estimates of coal reserves in Canada (1982) in megatonnes (continued)

(for definition of resource/reserve terminology see Appendices "B" AND "C")

Province	Coalfield	*Coal rank	Coal in mineable seams	Recoverable coal	Clean coal
NOVA SCOTIA	Cumberland-Springhill	hvb	0.1+	0.1+	NA
	Inverness	hvb	2.8	1.4	NA
	Pictou	hvb	0.2	0.1	NA
	Sydney	hvb	809	443	339
	TOTAL		812.1	444.6	339
NEW BRUNSWICK	Minto	hvb	5.8	5.7	NA
ONTARIO	Onakawana	lig	0	0	NA
SASKATCHEWAN	Estevan	lig			NA
	Willow Bunch	lig			NA
	Wood Mountain	lig	2 121	1 697	NA
	Sypress	lig			NA
	TOTAL		2 121	1 697	NA
ALBERTA PLAINS	Barrhead	sub	NA	NA	NA
	Battle River	sub	152	93	NA
	Blackfoot	sub	NA	NA	NA
	Bow Island	sub	NA	NA	NA
	Brooks	sub	NA	NA	NA
	Buffalo Hill	sub	NA	NA	NA
	Chain Lakes	sub	NA	NA	NA
	Comrey	sub	NA	NA	NA
	Cypress Hills	lig	NA	NA	NA
	Drumheller	sub	41	10	NA
	East Brooks	sub	NA	NA	NA
	East Edmonton	sub	NA	NA	NA
	Fox Creek	sub	NA	NA	NA
	Garden Plain	sub	NA	NA	NA

*lig = lignitic; sub - subbituminous; lvb = low volatile bituminous;
mvb = medium volatile bituminous; hvb = high volatile bituminous

Table 2 - Estimates of coal reserves in Canada (1982) in megatonnes (contined)

Province	Coalfield	*Coal rank	Coal in mineable seams	Recoverable coal	Clean coal
ALBERTA PLAINS	Grassy Lake	sub	NA	NA	NA
	Hussar	sub	NA	NA	NA
	Lesser Slave Lake	lig	NA	NA	NA
	Lethbridge	hvb	NA	NA	NA
	Lucky Strike	sub	NA	NA	NA
	Mayerthorpe	sub	3.1	2.0	NA
	Medicine Hat	sub	NA	NA	NA
	Morinville	sub	12.7	8.3	NA
	Musreau Lake	hvb	NA	NA	NA
	Red Deer	sub	6.0	4.4	NA
	Rolling Hills	sub	NA	NA	NA
	Sheerness	sub	170	126	NA
	South Swan Hills	sub	0	0	NA
	Standard	sub	NA	NA	NA
	Taber	sub	NA	NA	NA
	Thorhild-Abee	lig	1.6	1.2	NA
	Tofield-Dodds	sub	1.3	1.0	NA
	Wabamun	sub	687	529	NA
	Wetaskiwin	sub	249.7	154.6	NA
	Isolated Deposits	lig-hvb	NA	NA	NA
	TOTAL		1 324	929	
ALBERTA FOOTHILLS	Coalspur	hvb	158	130	78
	Hannington	NA	NA	NA	NA
	McLeod River	hvb	NA	NA	NA
	Obed Mountain	hvb	145	110	68
	Turner Valley	hvb	NA	NA	NA
	Isolated Deposits	hvb	NA	NA	NA
	TOTAL		303	240	146

Table 2 - Estimates of coal reserves in Canada (1982), in megatonnes (concluded)

Province	Coalfield	*Coal rank	Coal in mineable seams	Recoverable coal	Clean coal
ALBERTA MOUNTAINS	Beaver Mines	hvb	NA	NA	NA
	Bellevue	hvb	NA	NA	NA
	Blairmore	mvb	NA	NA	NA
	Brule	lvb	NA	NA	NA
	Cadomin-Luscar	mvb	185	94	76
	Canmore	lvb	NA	NA	NA
	Coleman	mvb	NA	NA	NA
	Daisy Creek	NA	NA	NA	NA
	Kakwa River	lvb-hvb	NA	NA	NA
	Kananaskis	NA	NA	NA	NA
	Mountain Park	hvb	NA	NA	NA
	Nordegg	lvb	NA	NA	NA
	Oldman River	NA	NA	NA	NA
	Ram River	NA	NA	NA	NA
	Savanna Creek	NA	NA	NA	NA
	Smoky River	lvb	424	165	115
	Tent Mountain	mvb	NA	NA	NA
	Isolated Deposits	lvb	NA	NA	NA
	TOTAL		609	259	191
BRITISH COLUMBIA	Comox	hvb	16	15	10
	Crowsnest	lvb-mvb	596	472	397
	Elk Valley	lvb-hvb	1 166	1 102	735
	Flathead	lvb-mvb	NA	NA	NA
	Hat Creek	lig-sub	739	566	NA
	Peace River	mvb	759	509	357

Table 3 - 1982 coal reserves in Canada, by rank

Rank Region Coalfield	Coal in mineable seams (megatonnes)	Recoverable coal (megatonnes)	Recoverable coal heating value (petajoules)
LIGNITIC			
Saskatchewan All coalfields	2 121	1 697	23 800
British Columbia Hat Creek	739	566	6 800
Sub-total, lignitic	2 860	2 263	30 600
SUBBITUMINOUS			
Alberta	152	93	1 800
Battle River	41	10	200
Drumheller	12	8	100
Morinville	6	4	100
Red Deer	170	126	2 100
Sheerness	687	529	9 800
Wabamun	250	155	2 900
Wetaskiwin	6	4	-
Others			
Sub-total, subbituminous	1 324	929	17 000
BITUMINOUS			
Nova Scotia Sydney	809	443	12 000
New Brunswick Minto	5.8	5.7	200
Alberta	158	130	2 900
Coalspur	145	110	2 100
Obed Mountain	185	94	2 400
Cadomin Luscar	424	165	4 100
Smoky River			
British Columbia	16	15	400
Comox	596	472	11 800
Crowsnest	1 166	1 102	27 500
Elk Valley	759	509	12 700
Peace River			
Sub-total, bituminous	4 264	3 046	76 100
TOTAL, all ranks			123 700
BITUMINOUS METALLURGICAL, included in BITUMINOUS above			
Nova Scotia	243	133	
Alberta	609	259	
British Columbia	2 201	1 643	
TOTAL, metallurgical	3 053	2 035	

OPERATING COAL MINES AND PROJECTS UNDER DEVELOPMENT AS OF JANUARY 1, 1982

Readers will find in Appendix "E" a list, by coalfield, of operating coal mines and coal projects under development. Such a listing is but a snapshot of a dynamic industry which directly employed some 14,000 persons in its mining and preparation plant operations during 1981.

Coal operations range from established producers in historical coalfields to likely prospects in entirely new regions. Appendix "E" presents this information in three groupings, by coalfield, namely:

Part I: Operating Coal Mines

Part II; Coal Projects in the Construction-Development Stage

Part III: Coal Projects in the Planning-Development Stage

What constitutes a project in the planning-development stage can be a matter of opinion. For projects in Alberta and British Columbia, the provincial government's assessment procedure provides a useful measure of the degree to which individual projects have advanced. The step-by-step assessment of projects moving from exploration prospects to operating coal mines is detailed in references (7) and (8) for Alberta and British Columbia respectively.

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APPENDIX A - SELECTED CONVERSION FACTORS AND TERMINOLOGY

Multiply this		by this	to obtain	
British thermal unit (Btu)		1055.06	joule	J
Btu per pound		2.326	kilojoule per kilogram	kJ/kg
cubic yard		0.764 555	cubic metre	m^3
cubic yards per ton		0.842 78	cubic metres per tonne	m^3/t
foot		0.3048	metre	m
joule	J	0.000 947 8	Btu	
kilojoule per kilogram	kJ/kg	0.429 923	Btu per pound	
kilometre	km	0.621 371	mile	
litre per second	L/s	13.1982	gallon per minute	
megajoule per kilogram	Mj/kg	429.923	Btu per pound	
metre	m	3.280 84	foot	
mile		1.609 344	kilometre	km
short ton per acre foot		7.354 67	tonne per hectare metre	t/ham
ton (long)		1.016 046 908 8	tonne	t
ton (short)		0.097 184 74	tonne	t
tonne		0.984 206 5	long ton	
tonne		1.102 311	short ton	

SI PREFIXES

Multiplying Factor	Prefix	Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 19^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deca	da

APPENDIX B - RESOURCE CLASSIFICATION
(essentially from Report ER 79-9 (2))

A meaningful reporting of Canada's coal resources must be made in the context of a classification scheme that takes into account the great diversity of the nation's coal deposits. The coal resource classification scheme classifies the resources according to two basic considerations: (1) the assurance of their existence and (2) the feasibility of exploitation. Each of these considerations is subdivided into categories having defined parameters. The definitions of terms and parameters used in this scheme are given below. They are somewhat similar to those used in the United States (Averitt, 1969) but are modified to suit local conditions that are present in the Canadian coal deposits.

DEFINITION OF RESOURCE TERMS

Coal Resources

The term "coal resources" is defined as the coal that is contained in seams occurring within specified limits of thickness and depth from surface.

Assurance of Existence

The terms "measured", "indicated", "inferred" and "speculative" denote the level of confidence with which given quantities of resources have been determined or estimated; they are defined as follows:

Measured Resources are resources for which tonnages are computed from information revealed in outcrops, trenches, mine workings and boreholes. The spacing of points of observation necessary to justify confidence in the character and continuity of coal seams differs from region to region according to the character of the deposits and the geological conditions. In general the points of observation should be separated by less than the following distances:

Coal regions in Canada	Maximum distance between points of observation (in metres)
Cordillera* (150 m in severely contorted areas)	300
Plains	
Alberta	800
Saskatchewan	800
New Brunswick	400
Nova Scotia	
Sydney Coalfield, offshore	
Harbour and Phalen seams	1 600
Other seams	800
Sydney Coalfield, onshore	800
Other coalfields	300

Indicated Resources are resources for which tonnages are computed partly from specific measurements and partly from reasonable geological projections. For the general coal regions in Canada, the points of observation should be separated by less than the following distances:

Coal regions in Canada	Maximum distance between points of observation (in metres)
Cordillera (300 m in severely contorted areas)	600
Plains	
Alberta	1 600
Saskatchewan	1 600
New Brunswick	800
Nova Scotia	
Sydney Coalfield, offshore	
Harbour and Phalen seams	4 800
Other seams	1 600
Sydney Coalfield, onshore	1 600
Other coalfields	600

*Cordillera region includes all British Columbia and the Foothills and Mountain regions of Alberta.

Inferred Resources are resources for which quantity estimates are based largely on broad knowledge of the geologic character of the bed or region and for which few measurements of seam thickness are available. The estimates are based primarily on an assumed continuity of coal seams in areas remote from the points of observation used to calculate measured or indicated resources.

Speculative Resources are resources for which quantity estimates are based on information from a few scattered occurrences. Resources of this description are mainly in frontier areas where coal mining or exploration have not taken place.

Future Considerations

It is realized that it would be more meaningful to express the assurance of existence (level of confidence) by a range of possible error rather than by an arbitrary spacing of the points of observation. As an exaple, a measured resource estimate might be stated to have a level of confidence to within plus or minus 10 percent. To achieve this requires complex analysis.

Feasibility of Exploitation

Resources of Immediate Interest consist of coal seams that, because of favourable combinations of thickness, quality, depth, and location, are considered to be of immediate interest for exploration or exploitation activities. The conditions set out below do not apply rigorously in each case, but they give a general indication of thickness and depth of coal seams included in this category. In all areas, coal beds are included that are thinner or deeper than listed below but are nonetheless being mined at this time.

Cordillera: Coal of all ranks in beds at least 1.5 m thick that can be surface-mined.

Anthracitic and bituminous coal seams at least 1.5 m thick to a depth of 300 m, that are too deep for surface mining but might be mined underground.

Plains: (Alberta and Saskatchewan)	Bituminous and subbituminous coal beds at least 1.5 m thick to a depth of 230 m. Lignite seams at least 1.5 m thick that can be surface mined (generally to depths less than 45 m).
New Brunswick:	Seams at least 0.4 m to a depth of 24 m.
Nova Scotia:	
Offshore:	Seams at least one metre thick to a depth of 1 200 m.
Onshore:	Seams at least 0.5 m thick to depths of 45 m and all seams at least one metre thick to depth of 1 200 m.

Resources of Future Interest consist of coal seams that, because of less favourable combinations of thickness, quality, depth, and location, are not of immediate interest but may become of interest in the foreseeable future. The following limits are applied (excluding the resources of immediate interest described above):

Cordillera:	Seams at least 1.5 m thick to depths of 750 m.
Plains: (Alberta and Saskatchewan)	Seams at least one metre thick to depths of 450 m.
Nova Scotia:	
Offshore:	Seams at least one metre thick with depths in excess of 1 200 m.
Onshore:	Seams at least one metre thick with depths in excess of 1 200 m.

Future Considerations

When new mining technologies and/or changing economic conditions have indicated the possibility of mining thinner or deeper seams, or seams that are otherwise currently excluded from the estimates, it may become necessary to change the parameters for determining the feasibility of exploitation so as to include these coals in the estimates.

APPENDIX C - RESERVE CLASSIFICATION

The terminology used in this report is similar to that given in Report ER 79-9, excepting that "mineable coal" has been replaced by the term COAL IN MINEABLE SEAMS.

COAL IN MINEABLE SEAMS is that part of measured and indicated resources of immediate interest that can be considered for mining using current technology and economics, before there is any allowance for mining losses. To qualify as COAL IN MINEABLE SEAMS the following conditions must apply:

- that feasibility studies have been done, specific plans for mining method and processing (if needed) have been adopted and the overall economic feasibility for developing the coal deposit appears favourable.
- that the necessary infrastructure (townsite, power and transportation facilities) is either in place or can be amortized through coal sales.
- that the coal is legally accessible for excavation i.e. the development considered is beyond the prospectus or initial disclosure stage in the regulatory process and has received approval-in-principle from the provincial government concerned with controlling development.
- that all coal being considered for development is likely to be marketable at minimum acceptable profit levels.

RECOVERABLE COAL is that part of COAL IN MINEABLE SEAMS that would be recoverable as run-of-mine or raw coal, making allowances for mining losses. For example, in surface mining, a portion of the top of a seam will likely be lost with overburden in the stripping operation, or a part of the seam next to the spoil pile will not likely be excavated. In underground operations the most common mining loss is associated with pillars left as supports or barriers.

CLEAN COAL is that part of RECOVERABLE COAL that remains as the prime saleable product after upgrading in a preparation plant.

SALEABLE COAL is coal that meets saleable specifications; it may be clean coal with acceptable moisture content or raw coal that is ready to be used without further upgrading. Saleable coal differs from CLEAN COAL in that its quantity includes losses in shipment and, in most instances, moisture added in processing.

APPENDIX D - QUALITY CHARACTERISTICS OF COAL IN CANADA, BY REGION AND COALFIELD (continued)

Region/Coalfield	Rank	Current use (potential use)	Proximate analysis % (1 run-of-mine coal, 2 clean coal)	M	A	VM	FC	Sulphur %	Heating value (moist basis) MJ/kg	Remarks
NOVA SCOTIA										
Sydney Coalfield	hvb	70% thermal 30% metallurgical	1 2	5-8 2-8	10-18 3-12	29-32 29-35	45-55 54-62	1-4 1-2.5	24-31 29-34	low ash, variable sulphur, high reactivity
NEW BRUNSWICK										
Minto Coalfield	hvb	thermal	1	1-3	15-20	31-34	47-50	6-8		high sulphur, high ash
SASKATCHEWAN										
Estevan Coalfield	lig	thermal	1	28-35	8-15	26-31	29-34	0.4-0.6	14-17	
Willow Bunch Coalfield	lig	thermal	1	36-40	10-13	23-24	26-27	0.5	12-13	high moisture
ALBERTA PLAINS										
Battle River Coalfield	sub	thermal	1	23-25	6-12	30-35	36-38	0.3-0.4	18-20	
Lethbridge Coalfield	sub-hvb	(thermal)	1	9.5	10-20	35.5	36-44	0.5-0.6	21-24	
Sheerness Coalfield	sub	thermal	1	24-27	11-18	25-28	33-37	0.4-0.5	17-18	variable quality
South Swan Hills Coalfield	sub	(thermal, chemical feedstock)	1	22-24	21-22	24-26	30-31	0.3	15-16	
Wabamun Coalfield	sub	thermal	1	20-22	15-17	26-27	35-38	0.2-0.3	17.5-19.5	
Wetaskiwin Coalfield	sub	(thermal)	1	18-20	13-16	27-28	36-38	0.3-0.4	19-20	
ALBERTA FOOTHILLS										
Coalspur Coalfield	hvb	thermal	1 2	11 8.5-9.5	24-25 8-10	28 33	37 49	0.4-0.5 0.3	21 26	variable quality; clay bands in coal demand selective mining
Obed Marsh Coalfield	hvb	(thermal, chemical feedstock)	1 2	16-20 7-8	30-31 12-13	33 36	20 44	0.5 0.5	19 20	

Region/Coalfield	Rank	Current use (potential use)	Proximate analysis % (1 run-of-mine coal, 2 clean coal)					Sulphur %	Heating value (moist basis) MJ/kg	Remarks
				M	A	VM	FC			
ALBERTA MOUNTAINS										
Cadomin Luscar Coalfield	mvb	metallurgical (thermal)	1	5	12-20	18-20	55-65	0.3	30-31	
			2	8	10	22-24	58-60			
Smoky River Coalfield	lvb	metallurgical and some thermal	1	4	17-20	16	60-63	0.4	28	
			2	6	7	18	65-69	0.4	34	
BRITISH COLUMBIA										
Comox Coalfield	hvb	(thermal)	1	6	15.8	32.7	45.5	1.1	26	composite from 3 seams in Quinsam Project
			2	6-7	NA	NA	NA	NA		
Crowsnest Coalfield	lvb-mvb	metallurgical and thermal	1	4-5	15-20	19-23	55-60	0.3-0.4	30-31	clean thermal coal has higher ash and lower heating value
			2	8	9-10	21-22	59-61	0.3-0.4	31-33	
Elk Valley Coalfield	lvb-mvb -hvb	metallurgical and some thermal	1	3-5	20-35	19-33	40-60	0.3-0.5	20-25	several blends of clean coal are produced
			2	8	6.5-10	21-34	50-64	0.3-0.5	30-37	
Flathead Coalfield	mvb	(thermal, metallurgical)	1	3-6	25-35	22	40-50	0.5	20-25	% VM is an average value
			2	NA	NA	NA	NA	NA		
Hat Creek Coalfield	lig-sub	(thermal, chemical feedstock)	1	23	32	24	21	0.4	11.6	values shown are averages for a highly variable coal
Peace River Coalfield	mvb	(metallurgical and thermal)	1	6	20-30	21-27	45-55	0.3-0.5	21-26	
			2	6-8	6-9	22-24	63-66	0.3-0.5	33-36	clean metallurigcal coal
			2	8	16	20	56	0.3-0.5	28-30	clean thermal coal

Abbreviations used for rank: lig = lignitic; sub = subbituminous; hvb = high volatile bituminous; mvb = medium volatile bituminous; lvb = low volatile bituminous

Abbreviations used for proximate analysis: M = moisture; A = ash; VM = volatile matter; FC = fixed carbon

APPENDIX E - OPERATING COAL MINES AND MINES UNDER DEVELOPMENT AS OF January 1, 1982

(Part I: Operating Coal Mines; Part II: Coal Projects in the Construction-Development Stage: Part III: Coal Projects in the Planning-Development Stage)

Part I: Operating Coal Mines (continued)

Coalfield/Mine	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Recent Annual Raw Coal Production, Tonnes
NOVA SCOTIA				
Sydney Coalfield				
Lingan Mine	Cape Breton Development Corp. (CBDC)	Advancing longwall Some room-and-pillar	High-volatile A bituminous Harbour Seam; 1-3% sulphur	1,800,000 t.p.y. metallurgical & thermal
No. 26 Colliery	CBDC	Advancing longwall	High-volatile A bituminous Harbour Seam; 1-2% sulphur	1,100,000 t.p.y. metallurgical & thermal
Prince	CBDC	Retreating longwall (short-faces); room-and-pillar (development)	High-volatile A bituminous Hub Seam; 3-5% sulphur	250,000 t.p.y. thermal
Pit at Pt. Aconi	Thomas Brogan & Son	Strip mining	High-volatile A bituminous Bonar Seam; 3-6% sulphur	75,000 t.p.y. thermal
Pit at Pt. Aconi	NOVACO	Dragline stripping	High-volatile A bituminous Sydney Main Seam; 3-5% sulphur	200,000 t.p.y. thermal
SELMINCO	Discard dump reclamation at Sydney Mines	Loader/trucks	High-volatile A bituminous	60,000 t.p.y. thermal
Inverness Coalfield				
St. Rose Mine	Evans Coal Mines Ltd.	Room-and-pillar	High-volatile B bituminous No. 5 Seam; 4-5% sulphur	45,000 t.p.y. thermal

Part I: Operating Coal Mines (continued)

Coalfield/Mine	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Recent Annual Raw Coal Production, Tonnes
Pictou Coalfield				
Drummond Westville Mine	Drummond Coal Co. Ltd.	Room-and-pillar	High-volatile A bituminous Scott Seam; 1-2% sulphur	20,000 t.p.y. thermal
Discard dump reclamation	Thorburn Mining Ltd.	Loader/trucks	High-volatile A bituminous 1-4% sulphur	30,000 t.p.y. thermal
NEW BRUNSWICK				
Minto Coalfield				
Minto/Chipman Area Pits	New Brunswick Coal Co.	Dragline strip mining	High-volatile A bituminous Single thin seam; 6.5-8% sulphur	500,000 t.p.y. thermal
SASKATCHEWAN				
Estevan Coalfield				
Bienfait Mine	Bienfait Coal Co. Ltd. (Luscar Ltd. subsidiary)	Dragline strip mining	Lignite A; single seam in the Estevan Zone; 0.4-0.6% sulphur	500,000 t.p.y. thermal
Boundary Dam Mine	Manitoba and Saskatchewan Coal Co. Ltd. (Luscar Ltd. subsidiary)	Dragline strip mining	Lignite A; 2 seams in the Estevan Zone; 0.4-0.6% sulphur	1,850,000 t.p.y. thermal
Klimax Mine	Manalta Coal Ltd.	Dragline strip mining	Lignite A; single seam Estevan Zone; 0.4-0.6% sulphur	720,000 t.p.y. thermal
Souris Valley Mine	Saskatchewan Power Corp.	Dragline strip mining	Lignite A; two seams in the Estevan Zone; 0.4-0.6% sulphur	350,000 t.p.y. thermal
Utility Mine	Saskatchewan Power Corp. (Manalta Coal Ltd. operator)	Dragline strip mining	Lignite A; one seam in the Estevan Zone; 0.4-0.6% sulphur	2,400,000 t.p.y. thermal

Part I: Operating Coal Mines (continued)

Coalfield/Mine	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Recent Annual Raw Coal Production, Tonnes
Willow Bunch Coalfield				
Poplar River Mine	Saskatchewan Power Corp.	Dragline strip mining	Lignite A; one seam in the Hart Zone; 0.5% sulphur	1,800,000 t.p.y. thermal
ALBERTA'S PLAINS REGION				
Battle River Coalfield				
Diplomat Mine (No. 1578)	Forestburg Collieries Ltd. (Luscar Ltd. subsidiary)	Dragline strip mining	Subbituminous C; Battle River Seam; 0.4% sulphur	1,000,000 t.p.y.; thermal Paintearth Mine just beginning coal production
Paintearth Mine (No. 1781)	Forestburg Collieries Ltd. (Luscar Ltd. subsidiary)	Shovel/dragline strip mining	Subbituminous C; Paintearth Seam; 0.4% sulphur	
Vesta Mine (No. 1046)	Alberta Power Ltd. (Manalta Coal Ltd. operator)	Dragline strip mining	Subbituminous C; Single seam; 0.4% sulphur	1,100,000 t.p.y. thermal
Sheerness Coalfield				
Roselyn Mine (No. 443)	Manalta Coal Ltd.	Dragline strip mining	Subbituminous C; Single seam; 0.4% sulphur	70,000 t.p.y.; thermal (capacity 400,000 t.p.y.)
Wabamun Coalfield				
Highvale Mine (No. 1769)	Transalta Utilities Ltd. (Manalta Coal Ltd. operator)	Dragline strip mining	Subbituminous B; up to five seams; 0.3% sulphur	8,000,000 t.p.y. thermal
Whitewood Mine (No. 1757)	Transalta Utilities Ltd. (Manalta Coal Ltd. operator)	Dragline strip mining	Subbituminous B; up to five seams; 0.3% sulphur	1,500,000 t.p.y. thermal

Part I: Operating Coal Mines (continued)

Coalfield/Mine	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Recent Annual Raw Coal Production, Tonnes
Tofield-Dodds Coalfield No. 215 Mine	Dodds Coal Mining Co. Ltd.		Subbituminous C	60,000 t.p.y. thermal
Morinville Coalfield No. 1582 Mine	Egg Lake Coal Co. Ltd.		Subbituminous C	
Thorhild-Abee Coalfield No. 1562 Mine	North Point Coal Co. Ltd.		Lignite A	
Red Deer Coalfield No. 809 Mine	Sissons Mine Ltd.		Subbituminous A/B	
Wetaskiwin Coalfield No. 1670 Mine	Warburg Coal Co. Ltd.		Subbituminous A/B	
ALBERTA'S FOOTHILLS REGION				
Coalspur Coalfield Coal Valley Mine (No. 1778)	Luscar Sterco (1977) Ltd. (75% Luscar Ltd. 25% Alberta Energy Co. Ltd.)	Shovel-truck and dragline stripping	High-volatile C/B bituminous; Val D'Or/ Mynheer Seams; 0.3% sulphur	5,000,000 t.p.y. thermal
ALBERTA'S MOUNTAIN REGION				
Cadomin-Luscar Coalfield Luscar Mine (No. 1768)	Cardinal River Coals Ltd. (50% Luscar Ltd. 50% Consolidation Coal Co. of Canada)	Shovel-truck stripping	Medium-volatile bituminous Jewel Seam; 0.3% sulphur	1,500,000 t.p.y. metallurgical (capacity 3,000,000 t.p.y.)

Part I: Operating Coal Mines (concluded)

Coalfield/Mine	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Recent Annual Raw Coal Production, Tonnes
Smoky River Coalfield				
No. 1774 Mine	McIntyre Mines Ltd.	Shovel-truck stripping	Low-volatile bituminous Seams No. 4, 10, 11; 0.4-0.5% sulphur	2,200,000 t.p.y. metallurgical and some thermal
No. 1765 Mine	McIntyre Mines Ltd.	Room-and-Pillar	Low-volatile bituminous Seams No. 4, 11; 0.4-0.5% sulphur	1,000,000 t.p.y. metallurgical
Coleman/Tent Mountain Coalfield				
Discard dump reclamation	Coleman Collieries Ltd.	Loader/trucks	Medium-volatile bituminous various seams	300,000 t.p.y. processed thermal
BRITISH COLUMBIA				
Crowsnest Coalfield				
Harmer Surface Mine	B.C. Coal Ltd.	Shovel-truck stripping	Low-volatile bituminous 10 Seam and 8 Seam; 0.3-0.4% sulphur	7,000,000 t.p.y. metallurgical and some thermal
Michel Underground Mine	B.C. Coal Ltd.	Hydraulic; some room-and-pillar	Low-volatile bituminous 10 Seam; 0.3-0.5% sulphur	700,000 t.p.y. (hydraulic) plus 150,000 t.p.y. (room-and-pillar); metallurgical coal
Corbin Mine	Byron Creek Collieries Ltd. (Esso Minerals Canada subsidiary)	Loader/trucks	Medium-volatile bituminous Mammoth Seam; 0.2-0.3% sulphur	1,000,000 t.p.y. thermal
Elk Valley Coalfield				
Fording River Mine	Fording Coal Ltd.	Shovel-truck stripping and dragline stripping	Low, medium & high volatile bituminous; multi-seams; 0.3-0.5% sulphur	5,600,000 t.p.y.

Part II: Coal Projects in the Construction-Development Stage (continued)

Coalfield/Project	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Projected Annual Raw Coal Production, Tonnes
NOVA SCOTIA				
Sydney Coalfield				
Donkin-Morien Project	DEVCO	Advancing longwall	High-volatile A bituminous Harbour Seam; 1-3% sulphur	Projected output of 3,000,000 t.p.y. of thermal coal by 1987
Lingan-Phalen Project	DEVCO	Advancing longwall	High-volatile A bituminous Phalen Seam; 1-3% sulphur	Projected output of 2,000,000 t.p.y. of thermal coal and metallurgical coal by 1987
Cumberland-Springhill Coalfield				
Springhill Project	NOVACO	Dragline stripping	High-volatile A bituminous Rodney Seam; 1-4% sulphur	Projected output of 100,000 t.p.y. of thermal coal by 1983.
ALBERTA'S FOOTHILLS REGION				
Coalspur Coalfield				
Silkstone Project (No. 1796)	Luscar Sterco (1977) Ltd. (75% Luscar Ltd. 25% Alberta Energy Co. Ltd.)	Room-and-pillar	High-volatile C bituminous Upper and Lower Silkstone Seams	700,000 t.p.y. thermal; 1983
ALBERTA'S MOUNTAIN REGION				
Cadomin-Luscar Coalfield				
Gregg River Project (No. 1770)	Gregg River Resources Ltd. (Manalta Coal Ltd. and others)	Shovel-truck stripping	Medium-volatile bituminous Jewel Seam; 0.3% sulphur	2,700,000 t.p.y. metallurgical and some thermal; 1983
Hydraulic Mine Project (No. 1792)	Cardinal River Coals Ltd. (50% Luscar Ltd. 50% Consolidation Coal Co. of Canada)	Hydraulic mining	Medium-volatile bituminous Jewel Seam; 0.3% sulphur	1,300,000 t.p.y. metallurgical; 1984

Part II: Coal Projects in the Construction-Development Stage (concluded)

Coalfield/Project	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Projected Annual Raw Coal Production, Tonnes
BRITISH COLUMBIA				
Elk Valley Coalfield				
Greenhills Project	B.C. Coal Ltd./Pohang Iron and Steel Co. Ltd.	Shovel-truck stripping	Medium and high-volatile A bituminous; Seams 1, 7, 10, 16 and others; 0.3-0.5% sulphur	2,100,000 t.p.y. metallurgical and some thermal; 1983
Line Creek Project	Crowsnest Resources Ltd. (Shell Canada Resources Ltd. subsidiary)	Shovel-truck stripping	Low-and medium-volatile bituminous; Seams 8, 9, 10B, 10A and others; 0.3-0.5% sulphur	2,500,000 t.p.y. metallurgical and thermal; 1983
Peace River Coalfield				
Bullmoose Project	Teck Corporation/Amalgamated Brameda-Yukon Ltd.	Shovel-truck stripping	Medium-volatile bituminous; five seams; 0.3-0.5% sulphur	2,200,000 t.p.y. metallurgical; 1983-84
Quintette Project	Denison Mines Ltd. and partners	Shovel-truck stripping; some dragline stripping	Medium-volatile bituminous; multi-seams; 0.3-0.5% sulphur	7,000,000 t.p.y. of metallurgical and 1,250,000 t.p.y. of thermal; 1983-84

*** Part III: Coal Projects in the Planning-Development Stage (continued)

Coalfield/Project	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Remarks
ALBERTA'S PLAINS REGION				
Lethbridge Coalfield				
Kipp Project (No. 1787E)	Petro-Canada	Room-and-Pillar or Shortwall/longwall	High-volatile C bituminous; Galt Seam; 0.6% sulphur approx.	Thermal coal
Shaughnessy Project	Fording Coal Ltd.	Room-and-Pillar or Longwall/shortwall	High-volatile C bituminous; Galt Seam; 0.6% sulphur approx.	Thermal coal
Sheerness Coalfield				
Sheerness Project (No. 1782)	Forestburg Collieries Ltd. (Luscar Ltd. subsidiary) and Manalta Coal Ltd.	Dragline stripping	Subbituminous C; one main seam with splits and some from an upper seam; 0.4% sulphur	Projected output of 3,300,000 t.p.y. of thermal coal in 1986
South Swan Hills Coalfield				
Judy Creek Project (No. 1783E)	Esso Minerals Canada	Dragline stripping	Subbituminous C; Seams 3, 5, 7 and others; 0.3% sulphur	Thermal coal
Wetaskiwin Coalfield				
Genessee Project (No. 1785)	Edmonton Power (Fording Coal Ltd. operator)	Dragline stripping	Subbituminous A and B; Upper Main and Lower Main Seams; 0.3-0.4% sulphur	Projected output of 3,000,000 t.p.y. of thermal coal starting in 1986 and reaching capacity in 1987

*** Part III: Coal Projects in the Planning-Development Stage (continued)

Coalfield/Project	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Remarks
ALBERTA'S FOOTHILLS REGION				
Obed Marsh Coalfield				
Obed Marsh Project (No. 1791)	Union Oil Co. of Canada Ltd.	Dragline stripping	High-volatile C bituminous; Seams No. 1, 2 and others; 0.5% sulphur	4,900,000 t.p.y. raw coal production capacity to produce 3,000,000 tonnes saleable thermal coal; permit granted by ERCB for mine site development
BRITISH COLUMBIA				
Comox Coalfield				
Quinsam Project	Brinco/Weldwood of Canada Ltd.	Dragline, as well as shovel-truck stripping	High-volatile A bituminous; Seams No. 1 and 2, some Seam No. 3; 1.1% sulphur	Thermal; (addendum to Stage II report in preparation)
Elk Valley Coalfield				
Elk River Project	Elco Mining Ltd. (a consortium) plus other partners	Shovel-truck stripping	Low, medium and high volatile bituminous; multiple seams; 0.6% sulphur	Metallurgical and thermal (Stage II report approved Feb/79)
Flathead Coalfield				
Sage Creek Project	Rio Algom Ltd./Pan Ocean Ltd.	Shovel-truck stripping	Low- to medium-volatile bituminous; Seams 2, 4 Upper, 4 Lower and 5; 0.5% sulphur	Metallurgical and thermal (Stage II report in preparation)
Hat Creek Coalfield				
Hat Creek Project	B.C. Hydro and Power Authority	Shovel-truck stripping	Lignite to subbitimunous; four coal zones; 0.3-0.5% sulphur	Thermal: (Stage II report under review)

*** Part III: Coal Projects in the Planning-Development Stage (concluded)

Coalfield/Project	Owner/Operator	Mining Method	Coal Rank & Seam(s)	Remarks
Peace River Coalfield				
Burnt River Project	Teck Corporation	Shovel-truck stripping	Semi-anthracite; from three to six seams; 0.3-0.5% sulphur	Thermal; (Stage II report in preparation)
Carbon Creek Project	Utah Mines Ltd.	Longwall; also shovel-truck stripping	Medium-volatile bituminous; multiple seams; 0.8% sulphur	Thermal; (Stage II report in preparation)
Monkman Project	Petro-Canada and others	Shovel-truck stripping	Medium-volatile bituminous; Seams B1, B3, B4, B9 and others; 0.4-0.5% sulphur	Thermal and some metallurgical
Sukunka Project	B.P. Canada Ltd.	Room-and-pillar, in decending multi-seam extraction	Medium-volatile bituminous; Bird Seam, Upper and Lower Chamberlain Seams	Metallurgical coal; (Stage II report approved March/81)

Note: *** Projects assigned to Part III: Coal Projects in the Planning-Development Stage are those in Alberta which have either received approval-in-principle as set forth in preliminary disclosure, or have received approvals for test pits. In British Columbia approval-in-principle is considered to be the approved Stage II submission. Those projects with either Stage II approvals or with work underway for Stage II submissions have been included.

The assessment procedure for new coal projects in Alberta and British Columbia is detailed in references (7) and (8) respectively.